Design a Novel Compact Dual Band Slotted Micro strip Patch Antenna for WLAN and Bluetooth Applications

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SANJAY KUMAR SINGHAL

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Under the Guidance of

Dr. Rajesh Purohit

INSTITUTE OF ENGINEERING & TECHNOLOGY

JK LAKSHMIPAT UNIVERSITY, JAIPUR

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TOPIC: Design a Novel Compact Dual Band Slotted Micro strip Patch Antenna for WLAN and Bluetooth Applications

CONCEPTUAL FRAMEWORK & VARIATE STRUCTURE: Various mathematical models were developed for such antennas and its applications were extended to many other fields. The number of papers, articles published in the journals for the last fifteen years show the importance gained by them.

Mari Komulainen, Pekka Salonen, and Markku Kivikoski(2001) The return loss would be under -10 dB; it performed well having a matching of 32 dB for the lower and 13 dB for the upper resonant frequency. The bandwidth was over 100 MHz for both of these frequencies.

Bahadır S. Yıldırım(2006) The return loss has to be improved so that the 3.1–10.6 GHz band allocated by FCC can be fully utilized.

K. L. Lau, K. C. Kong, and K. M. Luk (2007) The experimental results reveal that it has wide impedance bandwidths (SWR < 2) of 21.1% (0.790 to 0.976 GHz) and 32.2% (1.698 to 2.350 GHz) in the lower and the upper frequency bands, respectively. Therefore, it is capable to cover the operating bandwidths of several wireless communication systems included BLUETOOTH and WLAN.

C. H. See, R. A. Abd-Alhameed, D. Zhou, and P. S. Excell(2008) The optimum (minimized) volume of the proposed antenna gives 8% bandwidth at lower resonant mode of 2.4GHz while at the higher resonant mode of 5.500 GHz a bandwidth of 12.2% is obtained.

Xianwei Yu, Zenghui Yang, Qunsheng Cao(2010) It is found that the return loss of -22.42dB is achieved at the first resonant frequency of 9.13GHz and -23.52dB is obtained at the second resonant frequency of 9.88GHz. The antenna gives a stable radiation performance with gain greater than 16dB over the frequency band.

Mahmoud N. Mahmoud and Reyhan Baktur(2011) The antenna can be easily designed to operate effectively at 4.22 GHz and 5.26 GHz, which are downlink and uplink frequencies for satellite communication at C band.

A micro strip antenna is characterized by its Length, Width, Input impedance, Gain and Radiation pattern, etc. The patch is generally made of conducting material such as copper or

gold and can take any possible shape. The various parameters affect the performance of the micro strip antenna like feed point location, width, height, probe diameter, finite ground plane. There are some of the important parameters need to be considered that characterize all antenna designs. Some of the parameters are interrelated and not all of them need be specified for complete description of the antenna performance. Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna Efficiency, Half-power Beam width (HPBW), Beam Efficiency, **Bandwidth**, **Return Loss**, **Voltage Standing Wave Ratio (VSWR)**, Polarization, Input Impedance

Bandwidth: The bandwidth of an antenna is usually defined by the acceptable standing wave ratio (SWR) value over the concerned frequency range.

Return Loss: The amount of power which is reflected back to the source from an incorrectly terminated end is known as return loss. A return loss of -40 dB is better than -20 dB

Voltage Standing Wave Ratio: Ratio of maximum voltage to the minimum voltage along the line.

The variance of all or nearly all of the possible influential independent variables not pertinent to the immediate problem of the investigation is kept at a minimum. It has the inherent virtue of the possibility of relatively complete control, eliminating the many extraneous influences that may affect the dependent variable, high degree of specificity in the operational definitions of his variables.

RATIONALE: With the recent development of dual band frequency operation, antenna design for dual band system has become a challenging topic. Compared with other antenna technologies, certain good characteristics, such as small size, wide bandwidth are required in the dual band antenna. In the past few years, new designs based on the slotted micro strip antennas have been used for handheld wireless devices because these antennas have low-profile geometry and can be embedded into the devices. New wireless applications requiring operation in more than one frequency band (multi band) are emerging. Dual-band and triple-band properties have gained popularity because of the multiple frequency bands used for wireless applications. The micro strip antenna is one of the most preferable for small equipment, especially when a built-in antenna is required. The micro strip antennas are the present day antenna designer's choice.

The continuous development of wireless communication systems has placed a demand for low cost dual band antennas. With the recent advances in telecommunication, the need for compact antennas has greatly increased. Electronic equipment has rapidly reduced in physical size due to the development of integrated circuits, especially in mobile communication and computers the demand for the smaller antennas is quite strong. The aim of this research is to simulate and design a compact regular slotted micro strip patch antenna for WLAN and Bluetooth applications with good bandwidth.

OBJECTIVES:

- This proposal presents a dual frequency micro strip patch antenna with operating frequencies at 2.55 GHz and 5.35 GHz. Therefore, this antenna can be used in WLAN, Bluetooth and HIPERLAN applications.
- Some parametric study is to be done to optimize the results and antenna can be fabricated for the same. The simulation is to be carried out using anyone of the tool like Ansoft designer, HFSS, IE3D, CST Microwave studio etc.
- Both WLAN and Bluetooth operate at the ISM band (Industrial, Scientific and medical bands). The most common WLAN standard IEEE 802.1Ib is deployable today and it provides the possibility to replace wires in offices or places where it is difficult to use wired LANs. Bluetooth technology is a forthcoming wireless personal area networking (WPAN) technology, which was originally designed for cable replacement. Bluetooth wireless technology is a specification for small-form factor, low-cost, short range radio links between mobile PCs, mobile phones and other portable devices.
- The work with Micro strip patch antennas is related to microwave antennas technology. The huge significance of this project is theoretical as well as mathematical in wireless communication Engineering.
- My Current Focus is to find out the best suitable micro strip antenna with slots.

METHOD: A Communication device requires dual frequency operations and these requirements are fulfilled using slots on the micro strip antenna. The slotted rectangular micro strip patch antenna with dual frequency operations can be implemented for WLAN and blue tooth applications.

- **The study: Laboratory Experiments -** An experiment is an orderly procedure carried out with the goal of verifying, refuting, or establishing the validity of a hypothesis. Experiments provide insight into cause and effect by demonstrating what outcome occurs when a particular factor is manipulated. Experiments vary greatly in their goal and scale, but always rely on repeatable procedure and logical analysis of the results.
- **The Design:** Various steps are involved in the simulation process of the Micro strip patch antenna

Step 1: Insert a Planar EM design.

Step 2: Create the metal and dielectric layers of the design.

Step 3: Assign a thickness, roughness, elevation, and material to each layer.

Step 4: Draw the geometry of the metal layers (like rectangular, circular etc).

Step 5: If applicable, create a cavity between two infinite ground planes.

Step 6: Define the ports or incident waves in the model.

Step 7: If applicable, insert an external device, an *N-port*, with known S-parameters into the planar design.

Step 8: Specify how Designer will compute the solution by adding a solution setup.

Step 9: Begin the analysis. Designer will compute the current inside the structure.

Step 10: After computing a solution, view information about the solution and analyze it.

Antenna design will be based on the previously developed dual frequency micro strip patch antenna. Dimension of the structure Length L=30mm, Width W=38mm, Height of substrate h=1.6mm. For wireless antenna applications, a low-cost substrate with tight dielectric tolerance, low thickness tolerance and low dissipation factor ($\tan\delta < 0.005$) is required. However, the relative permittivity (ε_r) of FR4 is approximately 4.2 - 4.5, whereas ε_r , for more expensive substrate materials is 3.0 or under. Compared to the requirements above, FR4 epoxy has a poor dielectric tolerance (5.0%), high thickness tolerance (+ 9.8%) and high dissipation factor ($\tan\delta = 0.02$ at 1 MHz). A rectangular micro strip patch antenna with narrow slots is to be designed and investigated for dual-band applications. The size of

proposed antenna is 38mm x 30mm (WxL). The proposed antenna consists of a rectangular micro strip patch antenna with narrow slots on 5mil FR4 epoxy substrate with probe feed. The S_{11} parameter, VSWR, gain and radiation patterns of the antenna are to be obtained using Designing software.

- **The Sample:** Purposive sampling procedure is adopted due to specific frequency band application. As we set up the problem, we specify whether to solve the problem at one specific frequency or at several frequencies within a range.

  The sweep generation from 1 GHz to 6 GHz, sample size = 101, each sample sweep of 0.05 GHz

Frequency, f in GHz (1GHz = 10^9 Hz)

1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00
1.05	1.55	2.05	2.55	3.05	3.55	4.05	4.55	5.05	5.55	-
1.10	1.60	2.10	2.60	3.10	3.60	4.10	4.60	5.10E	5.60	-
1.15	1.65	2.15	2.65	3.15	3.65	4.15	4.65	5.15E	5.65	-
1.20	1.70	2.20	2.70	3.20	3.70	4.20	4.70	5.20	5.70	-
1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75	5.25E	5.75	-
1.30	1.80	2.30	2.80	3.30	3.80	4.30	4.80	5.30	5.80	-
1.35	1.85	2.35	2.85	3.35	3.85	4.35	4.85	5.35	5.85	-
1.40	1.90	2.40	2.90	3.40	3.90	4.40	4.90	5.40	5.90	-
1.45	1.95	2.45	2.95	3.45	3.95	4.45	4.95	5.45	5.95	-

- **Tools:** There are many tools are available for simulation of patch antenna, some of them are Ansoft Designer, HFSS, Micro stripes, IE3D and CST Microwave studio. In the Method of Moments, the surface currents are used to model the micro strip patch, and volume polarization currents in the dielectric slab are used to model the fields in the dielectric slab. An integral equation is formulated for the unknown currents on the micro strip patches and the feed lines and their images in the ground plane. The integral equations are transformed into algebraic equations that can be easily solved using a computer. This method takes into account the fringing fields outside the physical boundary of the two-dimensional patch, thus providing a more exact solution. The simulation technique that is used to calculate the *S*-

parameters and radiated fields for a structure is based on the mixed potential integral equation (MPIE). Although its implementation is largely transparent, a general understanding of the method is useful in making the most effective use. To generate a solution from which S-parameters can be computed, Designer employs the mixed-potential integral equation (MPIE) method. The method of moments (MoM) is applied to the MPIE to solve for J, the current distribution on the 3-D surface mesh. In designer, the surface of the geometric model is automatically divided into triangles and rectangles. This collection of triangles and rectangles is referred to as the mesh. A volume mesh is not generated inside the model because at high frequencies the skin depth is so small that a surface mesh is sufficient.

POSSIBLE OUTCOMES: Earlier, it was hard to visualize electromagnetic wave propagation and interaction. With today's advanced numerical & computational methods, and computational & visualization software and hardware, this dilemma can, to a large extent, be minimized. To address this problem, a major factor in the success of antenna technology has been the advances in computer design and numerical computation methods. Today antenna engineering is considered a truly fine engineering art.

It resonates at two frequencies 2.55 GHz and 5.35 GHz. Antenna covers the first frequency band from 2.45GHz to 2.75GHz with resonance frequency 2.55GHz and covers the second frequency band from 5.20 GHz to 5.45GHz with resonance frequency 5.35GHz. It presents a dual frequency micro strip patch antenna with operating frequencies at 2.55 GHz and 5.35 GHz. Therefore, this antenna can be used in WLAN and Bluetooth applications. The achieved frequency ranges lies in ISM band in the spectrum of EM waves which is applicable in several communication systems.

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CHAPTER OUTLINE:

Chapter 1 Introduction: About the conceptual framework and variate structure, rationale and objectives of the research.

Chapter 2 Review of Literature: Various mathematical models were developed for such antennas and its applications were extended to many other fields. The number of papers, articles published in the journals for the last fifteen years show the importance gained by them.

Chapter 3 Method:

The study - I described about the method of research (Experimental Research)

The design - It is covering the designing methodology of antenna. In addition with this I have listed the available tools for designing. The sample - Purposive sampling procedure is adopted and size of sample is taken = 101

Tools - Data Collection, Data Analysis, generate a solution from which S-parameters can be computed, Designer employs the mixed-potential integral equation (MPIE) method.

Chapter 4 Results: The results of the slotted rectangular patch antenna i.e. return loss, VSWR, gain, radiation pattern represent the effectiveness of the proposed design.

Chapter 5 Discussion: The results reflect that it is possible to produce dual band micro strip patch antennas, that meet initial product requirements for WLAN applications and perform moderately well when compared with the commercial product.

Chapter 6 Summary: Conclusion, Suggestions

The resonant frequencies can be varied over a wide frequency range and the input impedances are easily matched for both resonant frequencies. It is expected however further work is required in order to improve the current dual band antennas.

Chapter 7 Implications:

References:

Appendices: